# THE INSTITUTE OF PHYSICS

47 BELGRAVE SQUARE, LONDON, S.W.1.

# BULLETIN

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## PROCEEDINGS OF THE THIRTY-THIRD ANNUAL GENERAL MEETING

The Thirty-third Annual General Meeting of the Institute was held on Friday, May 29, 1953, in the Town Hall, Bournemouth. The President (Dr. C. Sykes) was in the Chair. A quorum being present, the Secretary read the notice convening the meeting. The Minutes of the previous Annual General Meeting held on June 5, 1952, were read and approved and then signed by the Chairman.

On the proposal of the Honorary Treasurer (Dr. S. Whitehead) seconded by Major J. W. Buckley (Fellow), the accounts and balance sheet for 1952 were unanimously adopted. The Honorary Secretary (Dr. B. P. Dudding) moved the adoption of the report of the Board for 1952 and this was seconded by Dr. A. C. G. Menzies (Fellow) and carried unanimously.

Dr. W. Rheinallt Thomas (Fellow) and Dr. R. Witty (Fellow) were appointed scrutineers for the ballot for election to the Board and for the election of an Honorary Fellow. On the receipt of their report the Chairman declared the following to be duly elected to fill the vacancies on the Board which would occur on September 30, 1953 :—

*President :* Dr. C. Sykes
*Vice-President :* Professor F. A. Vick
*Honorary Treasurer :* Dr. S. Whitehead
*Honorary Secretary :* Dr. B. P. Dudding
*Ordinary Members of the Board :* Dr. P. S. Henry, Mr. A. T. Pickles.

The Chairman then announced that Professor A. M. Tyndall had been elected an Honorary Fellow of the Institute.

Messrs. Knox, Cropper and Co. were re-elected auditors for the year 1953.

A vote of thanks to the President, Honorary Officers and members of the Board was proposed by Mr. M. Milbourn (Fellow), seconded by Dr. R. Taylor (Associate) and carried with applause. The Chairman moved votes of thanks, carried with applause, to the Honorary Officers of Branches and Groups at home and overseas, and to the many bodies who have allowed the use of their rooms for meetings during the year.

This concluded the business of the meeting.

## NOTICES TO MEMBERS

### X-ray Analysis Conference and Exhibition

The Autumn Conference of the X-ray Analysis Group of the Institute will take place in London on November 20 and 21, 1953.

The first two sessions will be devoted to X-ray diffraction equipment, the particular theme being X-ray film and counter methods. A further session will be concerned with identification by X-ray analysis methods. The evening discourse will be given by Dr. R. W. G. Wyckoff, of the National Institute of Health, U.S.A. An exhibition of X-ray crystallographic equipment is being arranged in connexion with the Conference.

Further details will be sent in due course to all members of the Group ; they will also be sent to others requesting them on application to the Conference Secretary, Mr. H. J. Goldschmidt, F.Inst.P., c/o The Institute of Physics, 47 Belgrave Square, London, S.W.1.

### International Conference on the Science and Applications of Photography

The Royal Photographic Society has arranged an international conference on the science and applications of photography which is to be held in London from September 19

to 25, 1953. The papers to be presented have been classified into the following sections : Photographic science ; Kinematography and colour photography ; Technique and applications of photography ; Photomechanical processes ; and History, literature and training in photography.

The fee for the conference is one guinea for members of the Society and lecturers and two guineas for non-members. One set of preprints of the papers presented in any one section will be presented to each person attending the conference. Sets of preprints of the papers presented in any other section will be obtainable for 5s. for each section.

Further information may be obtained from The Secretary, The Royal Photographic Society, 16 Princes Gate, London, S.W.7.

### Participating Societies

For many years the Physical Society, The British Institute of Radiology, The Faraday Society and the Royal Meteorological Society have been known as Participating Societies of the Institute and have been represented on the Board. Initially, the scheme of participation provided for other means of formal co-operation including subscription concessions but during the course of the last few years the formal provisions of the scheme have gradually been removed although co-operation in informal ways has been most cordial. Following discussion over the last few months, agreement has been reached that the participation of all the societies except the Physical Society shall be terminated and henceforward only the Physical Society will be directly represented on the Board of the Institute.

Arrangements are being made to ensure the fullest co-operation between the permanent officials of the Societies and the Institute.

### Meetings of the Board

The Board met on January 20, March 17, May 19 and July 21, the President (Dr. C. Sykes) being in the Chair on each occasion. The business discussed, other than confidential matters, has been referred to in the *Bulletin*.

### Representatives

In response to requests received, the Board has appointed the following representatives :

*Science Advisory Sub-Committee of the Poole College for Further Education :* Mr. C. F. Oxbrow (Associate)

*The County Borough of Ipswich Advisory Committee for Science :* Mr. H. A. Nancarrow (Fellow)

*The Governing Body of the Norwood Technical College :* Dr. J. S. Forrest (Fellow)

*Wolverhampton and Staffordshire Technical College Advisory Committee in Applied Science :* Dr. W. Betteridge (Fellow)

*British Standards Institution Committee on Units and Symbols Standards :* Dr. Ezer Griffiths (Fellow)

### Prizes for original contributions in the *Journal of Scientific Instruments*

The Board has awarded Bowen Prizes of fifteen guineas each to the following for their papers published in the *Journal of Scientific Instruments*.

Mr. G. T. Wright, B.Sc., of the University of Birmingham, for his paper on " A single-channel pulse height discriminator of high speed and stability " (p. 157, May 1952).

Mr. G. D. Dew, of the National Physical Laboratory, Teddington, Middlesex, for his paper on " On the preservation of groove-form in replicas of diffraction gratings " (p. 277, September 1952).

Mr. H. Aspden, B.Sc., of Trinity College, Cambridge, for his paper on " A method of measuring the magnetic permeability of rod specimens " (p. 371, November 1952).

These prizes are awarded to authors who are not more than 35 years of age whose papers are judged to be the best in respect of originality, scientific value, practical utility to instrument makers and users, and presentation, including the standard of presentation of the manuscript. Money for them is provided by the Scientific Instrument Manufacturers' Association of Great Britain Ltd. from the Bowen Trust Fund, established by the late Mr. William Bowen, who was a Fellow of the Institute.

### Membership Committee Examiners

Mr. A. E. De Barr (Fellow) will have completed his period of service as an examiner to the Membership Committee on September 30 next ; Mr. G. W. Warren (Fellow) has been appointed to succeed him. Mr. Warren is chairman of the Electronics Group and is the Institute's Assessor in Applied Physics for the examinations for the Ordinary and Higher National Certificates in Applied Physics. The other examiner at present serving is Professor A. M. Tyndall.

### Changes of Branch and Group Officers

Several changes of honorary officers of Branches and Groups have recently taken place. The new officers are as follows, the names of the previous officers being given in brackets.

*Scottish Branch.—Chairman :* Professor W. H. J. Childs (Professor J. S. Rankin). *Hon. Secretary :* Mr. T. H. O'Beirne (Mr. J. McNeill).

*Education Group.—Chairman :* Dr. J. Topping (Mr. W. Somerville Vernon).

*Electron Microscopy Group.—Chairman :* Dr. V. E. Cosslett (Professor W. T. Astbury).

*Industrial Radiology Group—Chairman :* Mr. W. E. Schall (Mr. C. Croxson).

*Stress Analysis Group—Chairman :* Mr. E. K. Frankl (Col. H. T. Jessop). *Hon. Secretary :* Mr. B. Sugarman (Mr. E. K. Frankl).

*X-Ray Analysis Group—Chairman :* Mr. H. P. Rooksby (Dr. W. H. Taylor).

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" *If you want science, you must begin by creating science teachers.*"
MICHAEL FARADAY (*in evidence to a Royal Commission*).

## RESEARCH ASSOCIATIONS

## II. — THE BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION

by A. J. MADDOCK, D.Sc., M.I.E.E., F.Inst.P.

### HISTORICAL BACKGROUND

Of all the Research Associations, the British Scientific Instrument Research Association can claim to be the oldest, having been formed in May 1918. It began in a small way with support from some fourteen firms, mainly from the optical instrument industry but after a year or so eleven electrical instrument and X-ray apparatus manufacturers had joined so that the scope of the work undertaken was considerably enlarged.

A brief glance at some of the major items of research undertaken during the first twenty years of existence of B.S.I.R.A. will indicate the very varied nature of the work. There were problems connected with the use of the old type of gas X-ray tube ; on the durability of polished surfaces of optical glasses ; on the magnetic susceptibility of materials used in galvanometer suspended systems ; the production of efficient phosphors for use in some of the first cathode-ray tubes made in this country ; the relative merits of radium and meso-thorium as activating materials for zinc sulphide ; design of the achromatic ring illuminator and the first British microscope object glasses for use with ultra-violet light. It was in this period that the Association designed and acquired an interferometer which enables quantitative tests to be made of the performance of microscope object glasses ; until recently this instrument was the only one of its kind in the world and tests on it are continually being made. Other investigations were concerned with moving coil ammeters and voltmeters of the switchboard type ; the behaviour of various metals when used as relay contacts ; the optimum conditions for cathodic sputtering of metals ; the characteristics of the X-rays resulting from the use of different types of high-tension generators ; design of the famous f/0.36 object glass for stellar spectroscopy incorporated in the 100 inch reflecting telescope at Mount Wilson, California—the enormous aperture of this lens has earned for it the description of " the fastest lens in the world."

During the two years immediately prior to the last war, when the re-armament programme had been initiated, the membership of the Association increased rapidly as more and more firms were required to produce instruments of all types outside their usual field, and many turned to the Research Association for help in these matters. From this date and right throughout the war period the Service Departments invoked the aid of the Association towards the solution of a multitude of problems and from these special mention might be made of four aspects of the work carried out :

Photographic methods of graticule reproduction were worked out which enabled graticules to be made for optical instruments of such accuracy that the precision of the instruments was greatly enhanced, and which also enabled production to be carried out at a much greater rate compared with older-methods—tens of thousands of these graticules were made by these processes; the Computing Department was busily employed in designing novel optical systems which were widely adopted in certain classes of Service instruments ; the technique of rendering optical components relatively non-reflecting (familiarly referred to as " blooming " and applied notably to lens surfaces) was developed and introduced into many Member Firms' works and help was given on the production of evaporated metal mirrors ; the Chemical Department was engaged on a host of problems connected with corrosion effects, and the development and use of greases, cements and other materials for various purposes.

*The Electronics Laboratory.*

*The Mechanical Laboratory.*

THE PRESENT ESTABLISHMENT

By the end of the War, the membership was four times that at the commencement, its scope had widened to include practically all types of scientific instruments but the experimental work was being carried out under the old restricted facilities appropriate to the needs of the earlier, small membership. The Council, therefore, proposed a scheme of expansion which involved quadrupling both the financial resources of the Association and its experimental facilities.

For the new laboratory premises, a suitable mansion at Chislehurst was acquired in 1946 and by the summer of 1947 experimental work on a much wider scale could be commenced. In contrast with the old premises at Russell Square, London, which served the Association from 1918-1947 and which were much damaged during the bombing periods, the new laboratories, which have been called " Sira," are pleasantly situated in semi-rural surroundings with 5 acres of accompanying grounds yet less than a half-hour's train journey from Charing Cross. The house and outbuildings contain some thirty rooms of assorted sizes and have lent themselves well to the purposes of conversion to laboratories without any major structural alterations. Two years ago a new building was erected on the site to house the Information Department and Library on the ground floor and a number of offices on the first floor. A headquarters office for general administration is maintained at 20 Queen Anne Street, London, W.1.

*The Physics Laboratory.*

Simultaneously with the expansion of the Association, eight departments were created, each comprising a Head of Department together with an appropriate number of staff, many of whom have of course, been recruited since the acquisition of the new premises and much new apparatus has been purchased. These departments are Chemical, Electrical,

Electronics, Information, Mechanical, Optical, Photographic and Optical Processes, and Physics. As each of these departments has a programme of research of direct interest to that particular section of the industry with which it is most closely associated and in addition does work of assistance to practically all the other branches it will be realised what a diversity of interest there is in the scientific instrument industry and what a wide field of work must be covered—from voltage stabilizers to spectacle lenses ; from flow meters to lubricating greases ; from amplifiers to thermometers. These are but a few typical examples of the range and in enlargement of these, some notes follow on the present activities.

The Chemical Department covers a multiplicity of activities ranging from the production of special greases and cements, through corrosion testing of instruments and finishes to the development and small-scale production of special glasses. An examination of polishing powders, as used in the optical and ophthalmic industries, is now in progress.

The Electrical Department has been concerned for a number of years with magnetic amplifiers, their component transductors and special circuits employing them for such applications as the amplification of the output from thermocouples and the control of voltage and frequency of electrical generators. A thorough investigation of special temperature-sensitive magnetic alloys has been carried out and the properties of electrical contacts at very light pressures are being studied.

In the Electronics Department the work can generally be divided into two main categories (*a*) instruments, circuits and systems, (*b*) electron physics. Under the first category the main interest to date has centred round d.c. amplifiers, voltage stabilizers, thickness gauging and the long-term behaviour of thermionic valves for instrument uses. Under the second, some fundamental work is being undertaken in the study of oxide-coated cathodes.

Heavy demands are made upon the services of the Information Department both in the giving of advice and information from journals, books and the like, in conducting literature searches, and also in advice on where to buy all manner of instruments. A monthly bulletin of abstracts is issued and some 250 journals are taken regularly. Much use is also made of the library facilities both by the member firms and by the laboratory staff.

Three lines of work occupy the experimental facilities of the Mechanical Department—measurement of rate of fluid flow by pressure-inferential methods, particularly in pipes of relatively small bore ; a study of glass grinding techniques using bonded-diamond tools ; the behaviour of precipitation-hardening alloys particularly when used in diaphragms and Bourdon tubes. Associated with the Mechanical Department are the Drawing Office and Workshop of a well-equipped nature.

The Optical Department is divided into two sections, the one dealing with the computation of lens systems and the like and the other the experimental section in which is carried out measurements of spectral transmission of glass filters and liquids, examination of optical components by interferometry, polarimetry, etc.

As already mentioned considerable effort has been put into methods of making graticules of a multiplicity of types by photographic means and this work comes under the Photographic and Optical Processes Department as does the preparation and examination of optical cements, a study of the etching of glass surfaces and the production of anti-glare glass windows for instruments.

*The Photographic Processes Laboratory.*

The Physics Department deals with such investigations as the measurement of relative humidity and, as a result of this work, some novel humidity-sensitive elements have been produced which can be used directly in an electrical indicating system ; a thorough examination of laboratory drying ovens to aid in producing a standard specification for these ; and a varied programme based upon interference effects to produce several types of optical filter, e.g. narrow band interference filters for the visible spectrum, heat reflecting filters and beam splitting cubes.

Finally a few words on the way in which the Association functions. In common with all the Research Associations Member Firms contribute a certain sum annually depending on their size and, provided the industry exceeds a certain subscription level, the Department of Scientific and Industrial Research contributes considerably to the annual income. In spite of this, the Association is a fully autonomous body and the nature of the research in the Laboratories is determined solely by the needs and desires of the industry. Control is vested in a Council elected from member firms and including some representatives directly nominated by D.S.I.R.

Six Panels, dealing with different subject interests, have been formed of technical representatives from the member firms and it is these panels which have the primary say in what work it is considered should be carried out at the Laboratories. The programme of research for each Department is worked out annually, in collaboration with the Laboratory staff, in this way and passed to the Council for approval. The Panels also meet three times a year when discussions occur on the progress of the work in hand at the Laboratories. Final results of any investigation are incorporated in research reports and, in digest form, in a monthly technical news bulletin which are circulated to interested member firms. By these means, and through liaison visits, a very close relationship is maintained with the members.

In addition to the agreed and often long-term items of research, *ad hoc* problems from individual firms are welcomed and, indeed, a very large number of these are dealt with annually, both by the Laboratories and the Information Department.

The total staff numbers around 80 and half of these are graduates but assistants are also recruited from other sources, for example directly after leaving school, many of whom proceed to work for qualifications such as the National Certificates or degrees in various subjects.

# PHYSICS IN TECHNICAL COLLEGES

## V — THE ROYAL TECHNICAL COLLEGE, SALFORD

By W. G. DARVELL, M.Sc., F.Inst.P.

### DEVELOPMENT OF THE COLLEGE

In 1889 the Technical Institutes' Act was passed which empowered Local Authorities to raise a penny rate for the building and equipping of Technical Schools. Salford Corporation immediately formed a Technical Instruction Committee and the site in Peel Park was chosen for the erection of a building. The building was officially opened on March 25, 1896, by Their Royal Highnesses the Duke and Duchess of York who afterwards became Their Majesties King George V and Queen Mary. The College is thus about to enter upon its 58th session.

The main building, which was designed for 1800 students, is still in its original form. The number of individual students in attendance during the session 1951-52 was 6254. It is clear that this number cannot be accommodated in the original building and at the moment the overflow is housed in various rented and adapted buildings. This is, however, a temporary measure. The Ministry of Education has generally approved plans for a new building to cost nearly £1,000,000 exclusive of equipment. This will be built in several phases, and it is expected that the first phase will be started within a year.

The College has always had a great regard for the welfare of its students, particularly for the difficulties of part-time students in industry.

### SCOPE OF THE WORK OF THE COLLEGE

The College comprises nine senior Departments and at present embodies a small Secondary Technical School. There are full-time courses leading to Higher Diplomas and London University degrees. Recently, " sandwich " courses have been successfully developed in which students spend six months at the College and six months in industry for a period of 3-4 years. The part-time day courses for London B.Sc., A.R.I.C., Grad.Inst.P., and H.N.C. for students in industry are a feature of the work of the College. Some 2300 students attend such courses from over 500 different firms. In addition there is a large number of evening courses.

The main catchment area has a radius of 15 to 20 miles in one of the most densely populated and important industrial regions in Great Britain. Students also attend from a much wider area. The most important industries in the area are concerned with mechanical and electrical engineering, and rubber, chemical and textile production. A large number of firms have research departments and there are two Research Associations with headquarters in the area. There are also research centres belonging to Government departments and several nationalized industries.

### THE DEPARTMENT OF PURE AND APPLIED PHYSICS

Although the College was one of the first to be set up under the 1889 Act, the Physics Department is of very recent origin. It was separated from the Electrical Engineering Department on September 1, 1949, having justified its status as a separate department. The present full-time teaching staff comprises Head of Department, one Senior Lecturer, two Lecturers and four Grade " B " Assistant Lecturers. In addition, there are twenty part-time Assistant Lecturers.

The major problem is that of accommodation. The two main laboratories are only of moderate size and are in continuous use from 9 a.m. to 9 p.m. throughout the week. On most days six different groups of experiments have to be set up for the various courses in each laboratory. The applied physics laboratories are situated in a house, across the road from the main building. These very difficult conditions will be remedied when phase two of the extensions is completed as the Physics Department, which will be entirely in the new building, will then comprise four lecture rooms, eleven laboratories, a workshop and the necessary offices and stores.

*Figure 1. General Laboratory.*

As is usual in all Physics Departments provision of suitable courses has to be made for the special requirements of other departments. In this connection elementary grade classes are provided for Chiropody, Textiles and Bakery, intermediate grade classes for Pharmacy, Engineering and Building and advanced classes for Chemistry. The Institution of Electrical Engineers recognizes our internal examination in Applied Heat, Light and Sound as giving exemption from that subject in the Joint Section " A " examination ; nearly seventy students are taking the examination this session.

### COURSES WITHIN THE DEPARTMENT

The courses within the department fall into four categories:

(*a*) those leading to a General or Special degree of London University,

(*b*) those leading to a Higher National Certificate in Applied Physics and Grad.Inst.P.,

(*c*) Post-Advanced Courses,

(*d*) Miscellaneous courses such as glass blowing and photography.

(*a*) *Degree Courses.* Full-time and part-time courses are provided for the General and Special degrees of London University. The full-time post-Intermediate course for the General B.Sc. in physics, pure mathematics and applied mathematics, or in physics, pure mathematics and chemistry extends over two years. The corresponding part-time courses extend over three years and normally involve attendance at the College for one whole day and one or two evenings per week. Students taking ancillary physics for Special chemistry take the General B.Sc. classes with an additional class in the third year. During the present session 125 students are attending the physics classes at General degree level. A recent feature is the increase in the number taking the degree in physics, pure mathematics and applied mathematics ; this session 54 have enrolled. In June 1952, 26 students obtained a General degree with physics as one subject ; one of these obtained a first class and six obtained a second class. In

addition 14 students passed the subsidiary physics for the Special degree in chemistry under the old regulations.

Students have up to the present been advised to take the General B.Sc. degree before proceeding to the Special degree in physics. The number continuing to the Special degree is relatively small and so the lectures are arranged to be common to full-time and part-time students. The syllabus is divided into six sections and four sections are dealt with in each session. The rotation is such that a full-time or a part-time student covers the course in two years and an evening student in three years. The total number attending during a given session is usually about twelve.

The College is a local centre for all the London University theory examinations and for Intermediate and General Certificate practical examinations.

(*b*) *National and Higher National Certificate Courses in Applied Physics.* The agreement between the Ministry of Education and the Institute of Physics upon the award of National and Higher National Certificates in Applied Physics occurred in 1945. The first students for the course at Salford were enrolled in 1947. They numbered 20 in all, six of whom were judged to be qualified to enter the third year of the Ordinary Certificate course. All six completed the course and obtained the Higher National Certificate two years later. For several years the total number in the course was only about 30, but this session this number has been doubled. It seems clear that the value of the course is now being appreciated.

For some time it has been felt that a student on leaving the College for employment in industry should have something more than an academic degree. With the institution of the National Certificates in Applied Physics there came the stimulus to develop the applied side of the department, applied physics being one of the subjects in each of the final three years of the five year course. Now, in the full-time degree course in physics and mathematics, applied physics is taken as an additional compulsory subject although it is not required in the London degree examination. As far as possible the subjects introduced into the applied physics have been chosen to suit the requirements of local industries which, in this area, are very varied indeed.

The difficulty of starting courses in applied physics is that in the initial stages the number of students is likely to be small. At Salford this problem has been solved by making the National and Higher National Certificate courses available to students wishing to take any particular branch without necessarily taking the complete certificate course. This has been achieved by carefully arranging the order in which the various subjects are taken, and their duration, in each of the three years. The following table will make this clear. It is assumed for this purpose that there are 28 weeks in the session ; in the departmental prospectus actual dates are given.

S.3. (Third year of Ordinary National Certificate).
Weeks 1– 4. Glass-blowing.
„ 5–12. Electronics.
„ 13–19. Vacuum theory and practice.
„ 20–23. Photometry and illumination.
„ 24–28. Industrial temperature measurement.

A.1. (First year of Higher National Certificate).
Weeks 1–12. Emission spectroscopy.
„ 13–22. Electronics.
„ 23–28. Strain measurement (electrical methods).

A.2. (Second year of Higher National Certificate).
Weeks 1– 7. Strain measurement (optical method).
„ 8–18. Absorption spectroscopy and interferometry.
„ 19–28. Electronics.

Now suppose a student has a General degree at pass standard and wishes to qualify for Grad.Inst.P. by taking two papers of the Institute examination, one of which is an applied physics subject. If he chooses Electronics then he obtains a continuous course throughout the session by joining the S.3 class for weeks 5–12, the A.1 class for weeks 13–22 and the A.2 class for weeks 19–28. There is a slight overlap but the classes are held on different evenings so this merely involves attendance on two evenings per week over a short period. Other courses can be chosen in a similar way.

A knowledge of glass-blowing and photography find frequent application in a physics laboratory. A course in each of these subjects, available to all students, is held on one evening a week throughout the session.

(*c*) *Post Advanced Courses.* Specialized post-graduate courses in engineering, chemistry, building and textiles have been held in the Manchester region for many years. About two years ago it was felt at this College that there was scope for similar courses in applied physics. After approval by a Regional Committee two such courses have been held here during the past session ; these were on " Non-destructive testing " (9 lectures) and " High vacuum practice " (8 lectures). During the session 1953-54 two further courses will be held ; these will deal with "Rheology" and the " Physical principles of electronic instruments in laboratory measurements and process control." The lectures in any course are given by a group of lecturers, each being a specialist in his own particular subject.

EQUIPMENT

The department is adequately equipped with the apparatus required to carry out the usual experiments for a Special degree course. Much of this is standard apparatus which has been purchased, while some, such as for example, the Curie-Chenevaux balance and the optical strain bench have been constructed in the department. One of the pressing major requirements of the department is a well-equipped workshop. At present all the precision machine work has to be carried out with the co-operation of the Mechanical Engineering Department.

The apparatus for interferometry and spectroscopy is fairly comprehensive, including, among the major items, the

*Figure 2. Spectroscopy Laboratory.*

Rayleigh and Michelson interferometers, Fabry-Perot etalon, Michelson echelon grating, Hilger constant deviation spectrometer, Hilger-Nutting spectrophotometer and Hilger medium quartz spectrograph.

For the other branches of applied physics already mentioned apparatus is gradually being accumulated. For temperature measurement there is a radiation pyrometer, disappearing filament pyrometer, platinum resistance thermometer with a Tinsley Callendar and Griffiths bridge and a thermocouple pyrometer. For vacuum techniques a glass system with rotary and diffusion pumps and complete with every type of gauge built-in, is in operation. A metal system is under construction for speed and conductance measurements, sputtering and evaporation processes, etc.

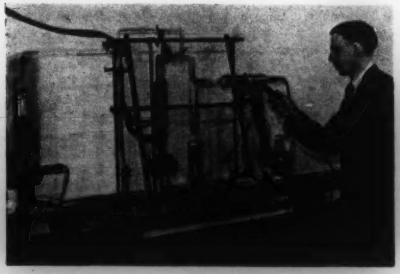

*Figure 3. Vacuum techniques Laboratory.*

X-ray courses will be developed in the near future. A 100 kV radiographic unit has been installed and a crystallographic unit has been ordered.

The Physics Department is responsible for the organization of the whole of the visual aids for the College. The visual aid equipment comprises sound and silent projectors, film-strip projectors and epidiascopes. Film strips are made in the department and it is hoped shortly to make technical cine-films. Provision is also being made for copying radiographs and documents. The visual aid equipment is complementary to the photographic equipment of the department and the combined equipment includes a Leica camera, a Bell-Howell cine-camera, Kodak half plate Specialist II Camera, spot-lights and flood-lights, De Vere and Kodak precision enlargers.

### RELATIONS WITH INDUSTRY

An applied science advisory committee comprises representatives of the professional institutions, including The Institute of Physics, and of employers and employees from industry. It normally meets twice during each session, or more often for special purposes. The committee has been of great assistance to the Physics Department in suggesting improvements in courses and in recommending additional equipment.

At intervals a member of the staff of the department is released from teaching duties to spend two or three weeks in the research laboratories of one of the large firms in the district. This is very valuable experience and enables useful contacts to be made. The staff is very grateful to the firms concerned for making this possible.

In this short account I have tried to give some idea of the way in which the department is trying to cater for the needs of students and of local industry. In conclusion I would like to say how we value the co-operation and interest of members of the Institute of Physics in fostering our work. We welcome personal contacts and are pleased to show anyone round the department at any time.

It may be of interest to members living in this area to know that the College is open next session for public inspection on Friday and Saturday, November 6 & 7, 1953.

## REVIEWS OF BOOKS

**Removing the Causes of War.** By KATHLEEN LONSDALE, D.Sc., F.R.S. (London : George Allen and Unwin Ltd.) Pp. 76. Price 5s. (paper cover 3s. 6d.)

This book gives an expanded version of the 1953 Swarthmore Lecture, delivered at Friends House, on May 22. The purpose of this annual lecture is " to interpret further to the Society of Friends their Message and Mission ; and to bring before the public the spirit, aims and fundamental principles of the Friends."

Although written by a distinguished scientist, and although it should be read by scientists as well as by everyone else, the book is important to them not as scientists, but as members of the community, as members perhaps of political organsiations, and especially as Christians, if such they claim to be. Some scientists do no doubt feel a special responsibility in view of the part they are called on to play in armament preparation, and these will find the book of particular interest. The basic problem of to-day however is to establish (or re-establish ?) an ethical foundation for our so-called civilisation, and here it now seems clear that science as such has little to offer.

Chapter IV will concern scientists particularly, as it severely criticises the idea that superiority in armament can act as a deterrent to war. The Dean of Chichester and Sir George Thomson are quoted as supporting this view, while Sir Winston Churchill and James Prescott Joule are quoted against it. The conception of a " just " war is then attacked equally vigorously. The later chapters admit the reality of evil and tyranny, and discuss the part which can be played by passive resistance, as distinct from appeasement. The work of service groups, the efforts of the individual, and the need for active planning for peace, are the subjects of the final chapters.

Some will argue that the whole approach is too idealistic to deal either with the present situation or the general problem of the impact of one culture upon another one less virile ; such are reminded throughout the book that all ethical progress has resulted from the efforts of very small minorities, whose task has never been an easy one.

D. A. WRIGHT.

**Lecture Notes on the Use of the Microscope.** By R. BARER, M.C., M.A., B.Sc., M.B., B.S. (Oxford : Blackwell Scientific Publications). Pp. vii + 76. Price 6s.

Most scientific instruments are straightforward to use, and if you know how to adjust them and to take the reading — you may have to read a vernier — you cannot but get the right answer. But this is by no means true of the microscope. Even if you have a sound knowledge of optics, are accustomed to the use of optical instruments and have some acquaintance

with the microscope, you will still fail to get the best out of the instrument without special instruction in its use. The designer of a micro-objective assumes that the light will pass through the objective along certain paths and fill the whole aperture of the objective and on this assumption calculates his curves to eliminate the various aberrations and to obtain a clean point-to-point image of the object that is being observed. Thus if the microscope is to work as it is intended the user must so arrange his illuminating system that the light follows the assumed path. Of the many thousands who are working with the microscope it is certain that only a small proportion know how to do this and therefore only these few are getting the full value from their equipment.

In this little book, Mr. Barer after short and simple descriptions of the microscope itself, of the method of image formation, the theory of the microscope (explaining resolving power, numerical aperture and their relation) and the lenses used, comes to three important chapters in which practical instruction is given for using the instrument. These instructions are very clear and definite so that with this book by his side even a beginner should have no great difficulty in setting up his microscope and getting good results. Other matters dealt with include the care and cleaning of the microscope and lenses and some interesting experiments with the instrument.

It is a useful book giving the intending microscopist a concise statement of the essential things he should know.

R. S. CLAY.

**Geometrical Optics.** By C. CURRY, B.Sc., Ph.D., A.Inst.P. (London : Edward Arnold and Co.). Pp. viii + 173 Price 21s. net.

**Introduction to Geometrical and Physical Optics.** By JOSEPH MORGAN. (London : McGraw-Hill Book Co.). Pp. ix + 450. Price 46s. 6d.

These two books can be conveniently reviewed together since the content of the first necessarily approximates to that of the first part of the second. Both books are intended for undergraduates and both are essentially orthodox in treatment. There have been changes, of course, from the geometrical optics found in the older text-books, for similar readers. Both these books, for example, contain treatments of the Seidel aberrations and discussions of the effects of apertures in optical systems. Dr. Curry starts with reflection and refraction at plane surfaces and explains the action of various kinds of prisms. This is followed by a chapter on image-formation by thin lenses and combinations of thin lenses, the need for a sign convention being clearly explained. After a chapter on instruments, of a somewhat elementary character, using thin lens treatment throughout, a return is made to more formal geometrical optics with a chapter on cardinal points. Then follow chapters on apertures and aberrations. The book concludes with a more detailed discussion of instruments. The first part of Prof. Morgan's book follows much the same lines, though the treatment tends to be fuller and rather more algebraic in character than Dr. Curry's, the bias in which is towards geometry.

Before proceeding further with comments specific to the two books under review, it seems appropriate to interpolate some remarks which I believe apply generally to books concerned with geometrical optics. It is quite likely that Conrady's *Applied Optics and Optical Design* had much to do with the above-mentioned changes in text-books on geometrical optics. Conrady made every effort to limit his subjects and methods "to what the late Silvanus P. Thomson called 'real optics' and to exclude the purely mathematical acrobatics which he called 'examination optics'." But he also remarked on "a deplorable tendency among students to concentrate on the mathematical equations and their proofs." Progress towards the first objective may therefore well be slow ! If so, this is unfortunate because only a very small proportion of students can reasonably be expected to become expert in the practice of detailed design of optical instruments, for it requires a particular aptitude and long study. On the other hand few physicists can always avoid the obligation to use or set up optical apparatus. This being so it is desirable that they should acquire some knowledge of optics, but by the easiest and least misleading ways. For this reason it is desirable to keep the cardinal points in their places : they may be interesting mathematically, but most students, I fancy, are inclined to say "So what ?" The theory of the perfect optical instrument (in Maxwell's sense) could be made quite simple, and it leads directly to such formulae as are useful in practice to those who do not claim to be optical designers. To understand the physics of optical instruments Huygens' construction is better adapted, in my opinion, than ray theory. Besides accounting for the action of plane and curved reflecting and refracting surfaces it enables the nature of the Seidel aberrations to be described easily and clearly, and indicates the sort of limitations there must be on the general theory of optical instruments. There are, of course, occasions when rays are more directly useful than wave surfaces, but they can always be regarded as normals to the wave-surface, when necessary. The classic elementary descriptions of microscopes, telescopes, cameras and projectors might well be supplemented by accounts of the 'schlieren' method, the principle of Maxwellian view, some of the uses of lenticular screens, or even the standard lamp and scale arrangement for reflecting galvanometers.

More particular criticisms of the books under review are that Dr. Curry's book has a few diagrams where the drawing has been careless, the directions of some of the rays being impossible, though not, in effect, seriously misleading. The diagram illustrating the action of the condenser in a projector is, however, definitely misleading. Both books may leave the impression that the Seidel aberrations tell the whole story of optical design. Prof. Morgan, for example, says "For practical purposes the inclusion of the third order term . . . is sufficient," when, I suppose, most optical designers would say that it is so difficult to include higher terms (though desirable) that the third order terms just have to be sufficient !

In spite of these criticisms, I would have no hesitation in recommending Dr. Curry's and Prof. Morgan's book to students, for so far as I know, there is as yet no book which meets all the above suggestions.

An interesting feature of Prof. Morgan's book is the provision in many places of alternative proofs, one using calculus and one without calculus—interesting because sometimes one is better adapted to a problem, sometimes the other. The treatment of physical optics follows well known lines. Here and there, however, points are made, in quite simple fashion, which do give some understanding of topics like the theory of dispersion, and scattering by particles, which one hardly expects to find in a fairly elementary text. The inclusion of a whole chapter on spectra seems somewhat surprising, in view of the rather sketchy treatment of the electromagnetic theory. The book is very well produced and can be recommended to undergraduate students.

E. W. H. SELWYN.

## CORRESPONDENCE

In the June 1953 issue of the *Bulletin* there appears a review of my book " General Properties of Matter " and in this review there are several mis-statements of fact. Now whereas any reviewer is entitled to his own opinions, I feel that incorrect statements of fact ought to be rectified. The reviewer suggests that the table on p. 390 is incorrect. It is correct and has been used for many years by my students.

It is also suggested that the Eötvos balance and Heyl's method for the determination of the gravitational constant should have been discussed ; yet in another place it is stated that the book is too comprehensive. I took specialist advice about the Eötvos balance and was assured that it is seldom used to-day. Now Heyl's method did not give the consistent results expected and, in principle, does not differ from Boys' method. Neither of these subjects can be discussed adequately in less than four to six pages of print, and, cost of production alone would exclude them.

In many university colleges the B.Sc. general degree course often extends over three years instead of a minimum of two and there is, in certain quarters, a feeling that the course will soon become a three-year one. The book was written with this in view and not for the candidate who is satisfied to pass at the lowest stage. The book is also intended to help special honours students in their first year. This was stated in the preface.

The reviewer claims that there is a tendency to oversimplify the argument and play down to the student. As a teacher of many years experience I find that to-day students are very often ill prepared to enter a university course in physics and need all the help that can possibly be given.

It is suggested that I should assist the reader to make an appropriate selection of the material of the book ; modesty would for ever prevent me from undertaking such a responsibility in view of the many different ways in which a syllabus may be interpreted.

In another small point the reviewer is in error ; he states that I have dealt with spiral springs. In truth, I have only dealt with closely coiled helical springs and, except in the index have been careful to avoid the word " spiral " which is often used, but incorrectly, to describe such springs. Finally why should not a chapter on high vacua be included in this part of the series ? To me it seemed most appropriate and is common practice.

C. J. SMITH.

Department of Physics,
Royal Holloway College,
London.

I regret that Dr. Smith should take exception to some of my remarks. Dr. Smith has made clear in this letter where he differs in opinion with me. The use of the term " spiral springs " is justified by the entry in the index " Spiral springs cf. helical springs." The discussion of the drop-weight method of determination of surface tension follows very closely the account given on pages 379–80 of N. K. Adam's book *The Physics and Chemistry of Solids*, 3rd Ed. (Oxford Univ. Press 1941) but, whereas Adam reproduces the table given in *International Critical Tables* (Vol. 4, p. 435) of $V/r^3$ and $1/F(V/r^3)$ so that $\gamma = (mg/r)F^{-1}$ (in Smith's notation) Dr. Smith on p. 390 gives, without any comment, a table of $V/r^3$ and $\log(1/F)$, an unfamiliar and inconvenient form. The use of the word " incorrect " in the review in this connection is, therefore, perhaps too severe, and should be replaced by " unusual and less useful form."

S. WEINTROUB.

The Physical Laboratory,
The University of Southampton.

## THE REGISTER

ELECTIONS TO MEMBERSHIP

An asterisk (*) indicates transfer from another grade.

*Fellows*

*Bardell, Philip Raymond, B.Sc., Scientific Staff, Research Laboratories, The General Electric Co. Ltd., Wembley.

*Caffyn, John Espenett, B.Sc., Lecturer in Physics, Durham Colleges, University of Durham.

*Chick, Douglas Richard, M.Sc., Section Leader, Nuclear Physics Section, Associated Electrical Industries Ltd., Research Laboratory, Aldermaston.

*Ireland, Arthur William, B.Sc., Director (Government Meteorologist), Sudan Meteorological Service.

Kreuchen, Karl Heinz, D.Phil., Research Physicist, Electric and Musical Instruments Ltd., Research Laboratories, Hayes, Middx.

Messel, Harry, B.A., B.Sc., Ph.D., Professor of Physics, University of Sydney, Australia.

*Taylor, Robert, M.A., B.Sc., Ph.D., Principal Scientific Officer, Research Branch, G.P.O., London.

*Walker, Darcy, M.Sc., Lecturer in Physics, University of Birmingham.

*Associates*

*Bisset, Douglas Chisholm, B.Sc., Ph.D., Research Physicist, Nickell Laboratories, Monsanto Chemicals Ltd., Ruabon, N. Wales.

Claringbull, Gordon Frank, B.Sc., Ph.D., Acting Keeper of Mineralogy, British Museum (Natural History), London.

Cole, John William, B.Sc., Head of Science Department, Towneley Technical High School, Burnley.

*Davis, Philip, B.Sc., Assistant Lecturer, Department of Applied Physics, Northampton Polytechnic, London.

*Duffin, William John, M.A., Lecturer in Physics, University College, Hull.

*Dyer, Arthur James, M.Sc., Senior Demonstrator in Physics, University of Melbourne.

Gupta, Manoranjan Prasad, M.Sc., Lecturer in Physics, Science College, Patna, India.

Harwood, Mervyn Geoffrey, B.Sc., Head of Fine Structure Group, Philips Electrical Ltd., Mitcham.

*Hinde, Robert Malcolm, B.Sc., Ph.D., X-Ray Research Crystallographer, British Insulated Callenders Cables Ltd., London.

*Knowles, Brian Geoffrey, B.Sc., Ph.D., Scientific Officer, National Coal Board, Stoke Orchard, Cheltenham.

McCall, David Rowland, B.Sc., Education Officer, R.A.F.

Margerison, Thomas Alan, B.Sc., Ph.D., Scientific Editor, Butterworth and Co. (Publishers) Ltd., London.

*Marsh, Kenneth John, B.Sc., Physicist, Research Division, The Metal Box Co., Ltd., London.

*Martin, Pauline Mary, M.Sc., Junior Research Officer, British Cotton Industry Research Association, Manchester.

Nixon, William Charles, M.A., Ph.D., Development Engineer, General Electric Co., New York.

Randle, Keith Charles, B.Sc., Physicist, The General Electric Co. Ltd., Wembley.

Salkauskas, Stasys, M.Sc., Physicist, General Radiological Ltd., London.

Smith, Michael Graham, M.A., Lecturer in Physics, University College, Khartoum.

*Todd, Malcolm Creighton Joseph, B.Sc., Physicist, Ministry of Supply, Division of Atomic Energy, Warrington, Lancs.
*Vernon, Edward Victor, B.Sc., Ph.D., Research Staff, British Insulated Callenders Cables Ltd., London.
Woods, John, B.Sc., Ph.D., Physicist, The General Electric Co. Ltd., Wembley.
*Zussman, Jack, M.A., Ph.D., Assistant Lecturer in Petrology, University of Manchester.

## APPOINTMENTS VACANT

**The inclusion of particulars of a vacancy must not be taken to imply that the Institute necessarily approves of the terms offered or that might be offered. Candidates should satisfy themselves that these are satisfactory, and they may always refer to the Institute for advice.**

**THE ROYAL TECHNICAL COLLEGE**
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(In affiliation with the University of Glasgow)

**Department of Natural Philosophy**
**Lectureship in Physics**

Candidates should have Honours Degree, special qualification in Electronics, Electron Microscopy, Photo-Elasticity, or other branch of Applied Physics an advantage. Successful applicant to participate in advanced courses for College Associateship in Applied Physics.

Salary scale £600 × £50 to £1,150.

Application forms from Secretary of the College.

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**The Quasi-Arc Company Limited** invites applications from honours graduates in physics, preferably with some research or industrial experience, particularly for work in X-ray diffraction. Please reply giving full details of qualifications and experience to the Secretary, The Quasi-Arc Co. Ltd., Bilston, Staffs.

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**University of Leeds—Temporary Research Assistant** required for one year only for an investigation into the submicroscopic structure of algal cell walls. Experience in culture of unicellular algae desirable. Salary of the order of £500. Application to be made to Dr. R. D. Preston, Biophysics Subdepartment, Botany Department, The University, Leeds 2.

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**Ministry of Supply,** A.E.R.E., Harwell, requires **Engineers** and **Physicists** in Electronics Division for duties ranging from fundamental research on circuitry and the physics of nuclear radiation detectors, to devising and developing (often in collaboration with industry) electronic devices for atomic Energy Project. Both small and large scale electronic engineering involved, with ample scope for originality. Duties mainly involve research on circuitry, but opportunities will occur for work on project engineering. Qualifications: minimum of 1st or 2nd class honours degree, or equivalent, in physics or electrical engineering. Appointment according to age and experience as: Principal Scientific Officer (min. age 31), £1,033—£1,377; Senior Scientific Officer (min. age 26), £781—£980 (for above grades at least 3 years post-graduate experience required); Scientific Officer, £417—£675. Women somewhat less. Appointments unestablished, F.S.S.U. benefits may be available. Houses available within reasonable period for successful candidates, if married. Application form, from M.L.N.S. Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A195/53/A. Closing date September 12, 1953.

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**Electrical Engineers** and **Physicists** required by **Ministry of Supply,** Farnborough, Hants, for theoretical and experimental research on design and performance of new weapons and associated guidance and control systems, Instrumentation of flight trials and analysis of trials data. Quals.: 1st or 2nd class honours degree or equivalent in Physics or Electrical Engineering with interest in electronics, servo mechanism theory or analogue computing. Salaries within range, Scientific Officer, £417–£675. Women somewhat less. Posts unestablished. F.S.S.U. benefits may be available. Application forms from M.L.N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A168/53/A. Closing date August 24, 1953.

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**Physicist** with good honours or higher degree required by Dunlop Research Centre to carry out fundamental research on Textiles. Previous experience desirable but not essential. Applications in writing, quoting reference J.M.5 and giving details of age, qualifications and experience, to Personnel Manager, **Dunlop Rubber Co. Ltd.,** Fort Dunlop, Erdington, Birmingham 24.

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**Admiralty R.N. Scientific Service.** The Civil Service Commissioners invite applications from **electronic engineers** or **physicists** for three permanent posts in Gloucestershire, as Principal Scientific Officer to take charge of teams responsible for design of large scale equipment and its devlopment to prototype stage.

Age at least 31 on December 31, 1952. Candidates must possess a first or second class honours degree or be corporate members of a recognised and appropriate professional institution, or produce evidence of outstanding ability. Research experience essential.

One post requiring ability to lead a team in design and development of radio receivers and ancillary equipment for use at frequencies above 30 megacycles. Two posts require knowledge of high speed electronic switching and data, storage and handling. Both digital and analogue techniques are relevant.

Inclusive London salary £1,075–£1,459 (men); £949–£1,280 (women). Somewhat less in provinces. Starting salary exceptionally above minimum according to qualifications and experience.

Particulars and application forms from Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, W.1, quoting No. S4226/53. Application forms to returned by August 20, 1953.

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**Instrument engineer** with sound theoretical and practical knowledge of pneumatic and electronic recording and controlling instruments, required to develop a department for the installation and maintenance of instruments, mainly connected with papermaking processes, in large modern paper mill. Salary according to qualifications and experience. Apply to the Chief Engineer, **Albert E. Reed & Co. Ltd.,** Aylesford Paper Mills, Larkfield, Nr. Maidstone, Kent.

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**National Coal Board** invite applications for a superannuable appointment on the staff of the Director of Scientific Control to carry out environmental studies at collieries in connection with a long-term field research into the occurrence and causes of pneumoconiosis. The appointment according to qualifications and experience, will be as Scientist Grade II (Salary Scale £645 × £30 to £1,095 per annum) ; Scientist Grade III (salary scale £445 × £25 to £845 per annum) or Scientific Technical Officer, Grade I (salary scale £730 × £25 to £880 per annum).

Applicants should have degrees (or equivalent) in physics, chemistry, mathematics or mining engineering. The present post will be located in the East Midlands (Nottingham) Division of the Board, but applicants should state if they would also be willing to serve in other areas if further vacancies should arise.

Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates) to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking envelope TT/655. Closing date August 24, 1953. Original testimonials should **not** be forwarded.

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**British Electricity Authority** require Junior Scientific Staff at the Research Laboratories at Leatherhead and Croydon. Candidates should have a Higher National Certificate or equivalent qualification in Electrical or Mechanical Engineering or in Physics. Duties include testing, development and research work in the Laboratories and in the field in connection with Generation, Transmission and Distribution of Electricity. Salary N.J.B. Grade 6 (Junior Engineer) £390—£606 (plus London Allowance at Croydon). Forms from D. Moffat, Director of Establishments, Winsley Street, London, W.1, to be returned by August 17, 1953. Quote reference BP/398.

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**Rowntree & Co. Ltd.** have vacancies in the production departments of their main factory at York for male science graduates under 30 years of age. The candidates selected will be suitably trained in general factory management. Good prospects for advancement either at York or with associated companies overseas (Canada, Australia, South Africa, Eire). The initial salary will be according to age and qualifications, and a pension scheme is available. Applications stating age, qualifications and experience to Staff Officer (men), The Cocoa Works, York.

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Applications are invited for the post of **Assistant Lecturer** (Grade "B") in Physics. The duties will be mainly concerned with Pure and Applied Physics but may include some Mathematics. Candidates should preferably possess an Honours degree in Physics. Experience or special interest in Applied Optics and Spectroscopy would be an advantage. Salary according to Burnham Technical Scale for Assistants Grade "B" (£490 by £25 to £765 per annum) with full additions for degree, training and experience.

Applications giving details of training and experience should be sent to the Principal, **North Staffordshire Technical College,** Stoke on Trent, immediately.

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**University College Hospital,** Gower Street, W.C.1, require a **Senior Physicist,** 1.10.53 or as soon as possible thereafter. Experience in radiotherapy physics essential.

Applications with the names of two referees to the Administrator and Secretary not later than August 31, 1953.

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**The British Steel Castings Research Association** invites applications for the following appointments :—

**Research Metallurgist or Physicist :** To be engaged upon fundamental studies of the mechanism of freezing of steel in refractory moulds, in particular the translation of basic data into terms of steel foundry practice, i.e. of feeder head dimensions and geometry. The appointment, which will carry either scientific officer or senior scientific officer status, according to qualifications is superannuable.

**Foundry Process Engineer :** To be engaged upon work related to the development and application of :—

(*a*) foundry plant for mould and core manufacture, and

(*b*) new moulding and casting techniques.

Applicants must have direct foundry experience (steel not essential) and must have a good general education. The appointment, which will involve liaison with industry and with the Association's appropriate technical committees and scientific panels, is superannuable with salary according to qualifications.

**Assistant Technical Secretary :** To assist in the provision of secretarial services to the Association's committees and panels and with the production of its internal publications. Applicants should be educated to degree standard, and experience in the field indicated will clearly be an advantage.

Applications, which in the first instance will be treated as confidential, should be addressed to : The Director, British Steelcastings Research Association, Broomgrove Lodge, Broomgrove Road, Sheffield 10.

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**National Institute for Research in Dairying** (University of Reading). Honours graduate, experienced in use of Infrared Spectrophotometer, required to assist in programme of research on various substances isolated from dairy products. The appointment will be in the grade of **Scientific Officer,** salary £418 to £676 (men) or to £545 (women) according to age, qualifications and experience. Superannuation under F.S.S.U. Applications with names of two referees, should be sent to the Secretary, N.I.R.D., Shinfield, near Reading. Quote reference 53/14.

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Further particulars of these courses may be obtained from the Principal, Technical College, Bradford.

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